combination of Cook and Sugiyama, namely that it would be obvious to modify Cook by having self-assembled quantum dot structures "for the purpose of providing a very sharp spectrum when used in an optical semiconductor device" is fundamentally flawed and does not stand up to scrutiny. The motivation given by the Examiner would require one to act in a manner directly contrary to the express teachings of Cook and Sugiyama as explained in more detail below.

Claim 1 recites a tunable laser having an active region comprising a multitude of self-assembled low dimensional quantum structures organized to have an emission and gain spectrum extending continuously over a wavelength of at least one hundred nanometers. Claim 1 also recites a wavelength selective element and an external cavity.

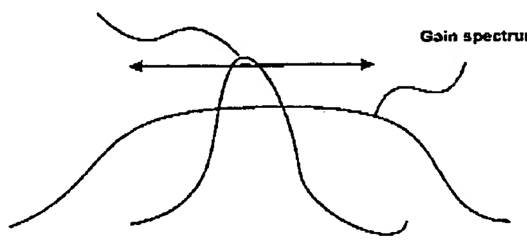
It will first be instructive to consider what we mean by gain spectrum and line sharpness. A laser consists of two principal components: a lasing medium and a resonant cavity. The resonant cavity, not the properties of the lasing medium, determines the wavelength of the laser and the sharpness of the laser beam. Clearly, the lasing medium must generate light at the wavelength determined by the resonant cavity. In a fixed wavelength laser, the lasing medium should have a reasonably narrow (sharp) emission spectrum at the wavelength determined by the resonant cavity because light falling outside the resonant wavelength is essentially wasted, thus rendering the laser inefficient. In a fixed wavelength laser any emission occurring outside this region is wasted because it is not used to generate the laser output.

In a tunable laser, it is still desirable to have a sharp laser output at any selected wavelength, but contrary to a fixed wavelength laser, the lasing medium needs to have a broad emission spectrum so as to allow the laser to be tuned to different wavelengths over as wide a range as possible. Clearly, if the resonant cavity is tuned to a wavelength outside the emission wavelength of the lasing medium, or at least at a wavelength where the output of the lasing medium is low, the laser will not operate satisfactorily.

There are therefore different requirements for fixed wavelength lasers and tunable lasers. Fixed wavelength lasers require a lasing medium with a sharp emission spectrum for maximum efficiency. Tunable lasers require a lasing medium with a broad emission

spectrum. Both types of laser desirably have a sharp laser output at the laser wavelength as determined by the resonant cavity.

The above situations can be understand better by way of the following illustration relating to a tunable laser. The laser output determined by the resonant cavity is narrow, but the gain spectrum of the emission medium needs to be broad so that the laser output can be shifted in the direction of the arrows and that the laser can operate anywhere in a broad range of wavelengths.



In the case of a fixed wavelength laser, any emission outside the spectral line determined by the resonant cavity would be wasted, leading to an inefficient laser.

This effect is shown in Figure 3 of the application, wherein the upper diagram shows the narrow output of the laser and the lower diagram shows the broad gain spectrum of the emission medium.

Cook discloses a tunable laser, and therefore requires a lasing medium with a broad emission spectrum so as to permit selection of a laser wavelength over a wide range of possible wavelengths. It would clearly be contrary to the understanding of one skilled in the art to provide Cook with a lasing medium having a sharp emission spectrum since such a lasing medium would inherently limit the wavelength range over which the Cook laser could be tuned.

This fact is expressly taught in Cook at col. 4, lines 40 – 42, where Cook states that the "broad spectral region 42 of low reflectance allows the external cavity laser diode system to be tuned over a wide wavelength range". See also column 4, lines 53 – 55, where Cook states "Thus, decreasing the reflectance of the anti-reflective coating 22 leads to a broader spectral gain bandwidth and, therefore, a broader tuning range for the external cavity

configuration of Fig. 2" . Although in this passage Cook is referring to the specifically to the properties of the mirror, which is the subject of the patent, clearly there would be no motivation to provide a mirror with a broad spectral range unless it was inherently understood that the emission medium had an emission spectrum extending over this broad range.

Sugiyama on the other hand teaches that a sharp gain spectrum is desirable and that spreading of the PL peak is "unwanted". See col. 2, line 51 of Sugiyama.

In summary, we have an express teaching in Cook that a "broad spectral gain bandwidth" is desirable because it leads to a broader tuning range. Sugiyama on the other hand, as the Examiner notes, expressly teaches producing an emission medium with a sharp peak.

How therefore can it possibly be legitimate, as the Examiner suggests, to add the teachings of Sugiyama to Cook for the purpose of "providing a very sharp spectrum" when the express teaching of Cook is exactly the opposite, namely that a medium with a broad spectral gain bandwidth is required? See Column 4, lines 53 – 55. In applicant's respectful submission such an alleged motivation, contrary as it is to the clear teaching of Cook and Sugiyama, makes no sense and is contrary to the established caselaw.

The applicants will not repeat the caselaw cited in the previous response, but as the Examiner is aware it is not permissible to combine references in a way which is contrary to the <u>express teachings</u> of the references themselves. If, as it does, Cook teaches that you need a <u>broad spectral gain</u> bandwidth for a tunable laser (col. 4, lines 53-55), and Sugiyama states that "spreading of the PL peak" is "unwanted" (co. 2, line 50-51) and teaches how to obtain a <u>sharp spectral</u> bandwidth for the emission medium, it must surely be clearly impermissible to combine Cook and Sugiyama because such a combination is contrary to the express teachings of each of the references. The reason for combining references must be found in the references themselves, not in the applicant's disclosure.

The Examiner's arguments attempt to destroy what, when one steps back from the mist of artificially constructed arguments, is in reality a very significant invention. Quantum dots are generally known for their <u>sharp</u> spectra. The inventor has seen beyond conventional thinking and taken advantage of an effect that has hitherto not been used for practical advantage, namely the broadening due to inhomogeneity and other effects that arise when

self-assembled quantum dots are formed, to use such a medium as a lasing medium in a tunable laser, which requires an emission medium with a broad gain spectrum. This inhomogeneous broadening is admittedly recognized in Sugiyama, but in Sugiyama it is seen as a problem to be overcome, not an effect that can be used to advantage. The fact that it is stated as a problem to be overcome would deter one skilled in the art from making use of it.

The applicants strenuously submit with respect that it cannot be anything other than hindsight to base an obviousness argument on a reference that identifies an effect used to advantage in the invention as a problem to be solved: "It is believed that the variation of the size of the quantum dots that foregoing unwanted spreading of the PL peak". (Emphasis added). See Sugiyama, col. 2, lines 50-52. Sugiyama then teaches how to avoid this "unwanted spreading". The inventors insight is that this "unwanted spreading" can be put to good use in tunable lasers. Such insight is clearly not taught in the prior art when taken alone or in combination. As pointed out by the CAFC in Arkie *Lures v. Gene Larew Tackle Inc.* 43 USPQ 2d 1294, the question to be answered is not whether one skilled in the art could have made the combination alleged to be obvious, but whether one skilled in the art actually would have done so taking into account all relevant factors. Surely a "relevant factor" is that Sugiyama teaches that inhomogeneous broadening is an unwanted effect.

For the above reasons, it is respectfully submitted that the invention cannot be considered *prima facie* obvious in the light of Cook and Sugiyama on any rational basis, and the Examiner is therefore earnestly requested to reconsider his position in the light of the above clarifications. A person skilled in the art starting with Cook and coming across Sugiyama would not be motivated to use the emission medium of Sugiyama in Cook because Cook teaches that a broad emission spectrum is desirable, whereas Sugiyama teaches that a broad emission spectrum is undesirable and he teaches how to decrease the breadth of the emission medium to make it sharp. These two requirements are diametrically opposed.

In summary, following the express teachings of both Cook and Sugiyama, one skilled in the art would not be motivated to use the emission medium of Sugiyama in a tunable

laser. It is respectfully submitted that the Examiner's alleged motivation of combining Sugiyama with Cook, namely to provide a "very sharp spectrum" does not stand up to scrutiny when one takes into account that the requirement for a tunable laser is that the emission and gain spectrum of the emission medium is not sharp, but broad, so as to allow the laser to be tuned over a wide range.

The undersigned would like to discuss this application with the Examiner, and the request for a telephone interview made in the previous response is respectfully repeated.

It is believed that this application is in condition for allowance and reconsideration and allowance are respectfully requested.

Respectfully submitted

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